Helminths Community of Veterinary Importance of Livestock in Relation to Some Ecological and Biological Factors

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SUMMARY: The goals of this study were: (*I*) to report the helminth population in cattle, sheep and goats; (*II*) to determine the concentration and diversity of the population; and (*III*) to study the role of host age, host sex, diet and season in structuring the population. A total of 485 cattle, 1144 sheep and 989 goats were examined for helminth population for four seasons. The helminth population consisted of nine species, four trematodes, four cestodes and one nematode. The overall infection prevalence in cattle, sheep and goats was 12.92%, 18.63% and 13.45%, respectively. *Echinococcus granulosus* was the most prevalent parasite. The overall mean species concentration per host was 1.23, 0.95 and 0.53 in cattle, sheep and goats, respectively. Species concentration, prevalence and mean abundance varied significantly in relation to host age, sex, diet and season. In conclusion, the influence of the factors investigated on structuring the helminth population of livestock, varied from species to another. We cannot say if the low species concentration and the recorded infection rates observed in the present study are typical of the host species or if they are due to characteristics of the study area, since there is no data available for other host populations.

Key Words: Parasite community, livestock, host age, sex, diet, season, species concentration

Çiftlik Hayvanlarının Veterinerlik Açısından Önemli Olan Helmintleri ve Bazı Ekolojik ve Biyolojik Faktörlerle İlişkisi

ÖZET: Bu çalışmada; (i) sığır, koyun ve keçilerdeki helmintlerin saptanması; (ii) toplumdaki çeşitlilik ve zenginliğinin belirlenmesi; (iii) konak yaşı, cinsiyeti, diyeti vemevsimsel faktörlerinin etkisinin belirlenmesi amaçlanmıştır. Toplam olarak, 485 sığır, 1144 koyun ve 989 keçinin dört mevsim boyunca helmintleri incelenmiştir. Dört trematod, dört sestod ve bir nematod olmak üzere dokuz çeşit helmint saptanmıştır. Genel infeksiyon prevalansı sığırda %12,92, koyunda %18,63 ve keçide %13,45 olarak bulunmuştur. *Echinococcus granulosus*'un en yaygın olan parazit olduğu belirlenmiştir. Konak başına genel olarak tür zenginliği sığırda 1.23, koyunda 0.95 ve keçide 0.53 olarak bulunmuştur. Tür zenginliği, prevalans ve ortalama yoğunluğun konağın yaşı, cinsiyeti, diyeti ve mevsime bağlı olarak değişiklik gösterdiği saptanmıştır. Sonuç olarak, çalışılan faktörlerin çiftlik hayvanlarında bulunan helmintlere olan etkisinin bir türden diğerine değiştiği görülmüştür. Buna karşın, bu çalışmada elde edilen infeksiyon oranlarının ve tür çeşitliliğinin konak türüne tipik olduğunu veya çalışılan alanın karakterlerine bağlı olduğunu söyleyebilmek için diğer konak populasyonlarının da incelenmesi gerektiğini düşünmekteyiz.

Anahtar Sözcükler: Parazit toplumu, hayvancılık, konak yaşı, cinsiyet, diyet, mevsim, tür zenginliği

INTRODUCTION

Cattle, sheep and goats play important role in economics of small-scall farmers living in villages or townships in West-South Saudi Arabia. These herds are seldom, if ever, treated for internal parasites. Helminths infection can result in losses in productivity through a reduction of feed intake and feed conversion efficiency, loss of blood and even death (5, 24, 26). Helminths cause great economic loss in livestock in Africa and Asia, and can be categorized as either direct or indirect losses. Parasites can have a wide range of impacts on

the ecology of their hosts in terms of health, behaviour, sexual selection and regulation of host populations. This makes interesting to examine them from the point of view of the ecological factors that determine parasite loads (27).

A number of factors, including growth, senility, changes in climatic conditions, malnutrition, concurrent infection with other pathogens, pregnancy and lactation, conditions result in general stress (16, 24). For domestic sheep and cattle it has been shown that host sex, age, season and feeding regime are factors that affect the outcome of infections with parasites (9, 12, 13, 20, 22, 23, 26, 29). The study of factors affecting helminths community of domestic animals are necessary for effective control using anthelmintics or other means of parasite control (14).

A few authors have described the effects of season, host sex and age on internal parasite burdens (9, 13, 29). Unfortunately, no information is available on the parasites of livestock in Al-Baha area, Saudi Arabia. The main goals of this study were: 1- to report the helminths community of cattle, sheep and goats; 2- to determine the concentration and diversity of the community and factors affecting species concentration; and 3- to study the role of host age, host sex, diet and season in structuring the community.

MATERIALS AND METHODS

The study was carried out in Al-Baha area, west-south Saudi Arabia (20° N, 41° - 42° E). The study area is mainly hilly, with small areas of either mountainous or flat land and extends from 500 to 2500 m a.s.l. The climate in Al-Baha has two extremes. Mild winters and hot summers, with an average annual rainfall between 100 and 250 mm, prevail in the lowlands; cold winters and mild summers, with an average annual rainfall between 229 and 581 mm, prevail in the highlands.

A total of 2591 livestock animals (458 cattle, 1144 sheep and 989 goats) were examined for helminths community during the four seasons from March 2006 to February 2007. All these animals were slaughtered in official abattoirs in Al-Baha city (20° N, 41° 46' E) and Baljurshi (20° N, 41° 50' E). The data collected for each animal (cattle, sheep and goats) included: a) host age (young <1 yr, or adult >1 yr); b) sex; c) feeding regime (grazed or non-grazed) and d) season. The structure of the sampled host population by the season of captured and host sex is shown in Table (1). The recovered parasites were collected and preserved; then processed in the laboratory for identification (15). Representative specimens of the parasites collection were deposited in the helminthology collection of the Al-Baha Teachers' College. The identification of helminths was carried out using keys provided by Soulsby (1982) and Georgi (1990).

Ecological terminology follows that described by Bush et al (1997). The difference in helminths community species

richens was tested by student's t-test for host sex and diet by analysis of variance (ANOVA) for season. Mann-Whitney (U-test) was used to test the differences in abundance and intensity per the host age, sex and host diet whereas Kruskal-Wallis test was used to test the difference in parasite abundance and intensity among different seasons. The difference in parasite prevalence was tested using Chi-square tests (χ^2). The degree of aggression of parasite species was calculated by the Index of dispersion (I = the variance to mean ratio (V/M: I >1 indicating overdispersion). The biodiversity of the community was analyzed by Simpson diversity. All the statistical tests were performed by using the software packages SPSS 12.0.0 (USA).

RESULTS

The helminths community consisted of nine parasitic species, four trematodes (*Dicrocoelium dendriticum*, *Fasciola hepatica*, *Fasciola giagantica* and *Paramphistomum cervi*), four cestodes (*Monezia expansa*, *Cysticercus bovis*, *Cysticercus ovis*, *Echinococcus granulosus* (hydatid cysts)) and one nematode (*Haemonchus contortus*). The overall prevalence of infection in cattle, sheep and goats were 12.92, 18.63 and 13.45% respectively. The overall mean abundance of infection in cattle, sheep and goats were 5.45, 2.84 and 1.97 respectively (Table 2). The mean intensity of infection in cattle, sheep and goats were 32.44, 15.24 and 5.53 respectively.

The species concentration in cattle, sheep and goats were 8, 6 and 4 respectively and the overall mean species concentration per host were 1.23 ± 0.20, 0.95 ± 0.18 and 0.53 ± 0.13 in cattle, sheep and goats respectively. The diversity in cattle, sheep and goats were 6.8, 5.4 and 4.4 respectively. The factors affecting species concentration of parasite community in cattle were host age ($t=5.78$; $P<0.0001$) host diet ($t=3.56$; $P<0.0001$) and season ($F_{3,455}=5.19$; $P=0.001$). The factors affecting spices concentration of parasite community in sheep were host age ($t=17.65$; $P<0.0001$) host sex ($t=2.09$; $P<0.0001$), host diet ($t=4.76$; $P<0.0001$) and season ($F_{3,1141}=2.78$; $P<0.04$) whereas in goats were host age ($t=9.01$; $P<0.0001$), host sex ($t=1.07$; $P=0.03$), host diet ($t=3.00$; $P=0.003$) and season ($F_{3,986}=3.79$; $P=0.01$).

E. granulosus (hydatid cyst) was the most prevalent parasite, followed by *H. contortus* in cattle, sheep and goats (Table 2). *P. cervi* recorded the highest mean abundance in cattle (69.99 $\pm$ 4.89); whereas *H. contortus* recorded the highest mean abundance in sheep (79.57±6.24) and goats (Table 1; 71.67 $\pm$ 12.76). On the other hand, *D. dendriticum* has the rarest prevalence and *M. expansa* recorded the lowest mean abundance (Table 2). The aggregation index (I) analysis showed that all helminth parasite species recorded in livestock in this study were aggregated in their hosts (V/M: I>1) except *M. expansa* (Table 2). The degree of aggregation of helminths differed according host species, cattle has the highest aggregation index (I) for each helminth parasite species (Table 2).

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There was variation in overall prevalence per host age in livestock animals. Adult animals of livestock have higher overall prevalence than young ones in sheep, cattle and goats (Fig. 1).

There was variation in overall prevalence of infection per host sex in cattle, sheep and goats. Male has higher overall infection prevalences than female in cattle, sheep and goats (Fig. 2). Overall infection prevalences differed significantly per host sex in cattle

Table 1. The structure of the sampled host population by the season and host sex.

	Goat		Sheep		Cattle		
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Total**
Spring	244	67	202	111	101	29	754
Summer	291	22	383	92	105	28	921
Autumn	207	35	175	110	93	22	642
Winter	108	15	67	4	78	2	274
Total	850	139	827	317	377	81	2591
Total sexes combined	989		1144		458		2591

Table 2. Prevalence and mean abundance ± SE of helminths of livestock in Al-Baha area, south Saudi Arabia.
(**P**: Prevalence; **MA**: Mean abundance; **I**: Aggregation index)

Parasites	Parasite habitat	Goats (*n*=989)			Sheep (*n*=1144)			Cattle (*n*=458)		
		P (%)	MA± SE (Range)	I	P (%)	MA ± SE (Range)	I	P (%)	MA ± SE (Range)	I
Trematoda										
Dicrocoelium dendriticum	Liver	0	0	0	0	0	0	1.22	11.38 ± 2.66 (0-15)	11.13
Fasciola hepatica	Liver	0	0	0	0.17	4.32 ± 0.02 (0-7)	6.32	1.22	11.70 ± 1.68 (0-13)	9.90
Fasciola giagantica	Liver	2.22	6.62 ± 0.48 (0-8)	5.48	4.02	9.95 ± 0.56 (0-15)	8.38	1.52	19.24 ± 5.05 (0-35)	21.61
Paramphistomum cervi	Rumen	0	0	0	0	0	0	11.55	69.99 ± 4.89 (0-150)	67.03
Cestoda										
Monezia expansa	Intestine	4.25	1.13 ± 0.04 (0-3)	0.99	10.48	1.28 ± 0.02 (0-2)	0.94	7.90	1.18 ± 0.02 (0-3)	0.98
Cysticercus bovis	Heart, rump	0	0	0	0	0	0	1.52	3.64 ± 0.037 (0-4)	2.98
Cysticercus ovis	Shoulders, thigh muscles and rump	0.61	1.46 ± 0.03 (0-3)	1.53	2.97	2.45 ± 0.31 (0-4)	2.66	0	0	0
Echinococcus granulosus (hydatid cysts)	Liver, mesenteries and lungs	12.71	6.42±1.61 (0-40)	20.96	17.03	12.97 ± 3.90 (0-85)	67.66	12.49	21.03 ± 3.99 (0-60)	37.33
Nematoda										
Haemonchus contortus	Abomasum & intestine	9.83	71.67±12.76 (0-86)	36.82	14.06	79.57±6.24 (0-120)	38.59	8.32	30 ± 4.47 (0-40)	33.08
Total helminths		13.45	1.97± 0.6 (0-86)	42.96	18.63	2.84 ± 1.4 (0-120)	65.04	12.92	5.45 ± 2.01 (0-150)	63.17

There were significant differences in overall prevalence in cattle (Fig. 1; χ^2 =21.88; *P<0.0001*), sheep (Fig. 1; χ^2 =198.71; *P<0.0001*) and goats (Fig. 1; χ^2 =85.62; *P<0.0001*). Overall mean abundance varied per host age (Fig. 1). Significant differences were found in mean abundance between age classes in cattle (*U*= 444451; *P<0.0001)*, sheep (*U*= 72756; *P<0.0001)* and goats (*U*= 80331; *P<0.0001)*.

(Fig. 2; χ^2 =201.36; *P<0.0001*), sheep (Fig.2; χ^2 =582.96; *P<0.0001*) and goats (Fig. 2; χ^2 =528.54; *P<0.0001*). Overall mean abundance was higher in female than male in cattle and goats. On the contrary, male has higher mean abundance than female in sheep (Fig. 2). Significant difference was found in mean abundance between male and female in sheep only (Fig. 2; *U*= 122605; *P=0.005*). No significant differences found in mean abundance in cattle and goats per host sex.
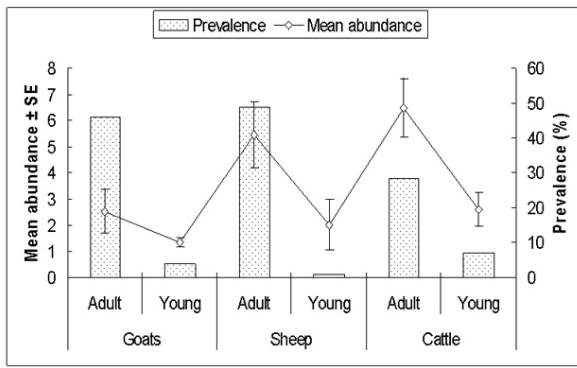
Figure 1. Overall prevalence and mean abundance (± SE) of all helminths combined in different types of livestock per host age.
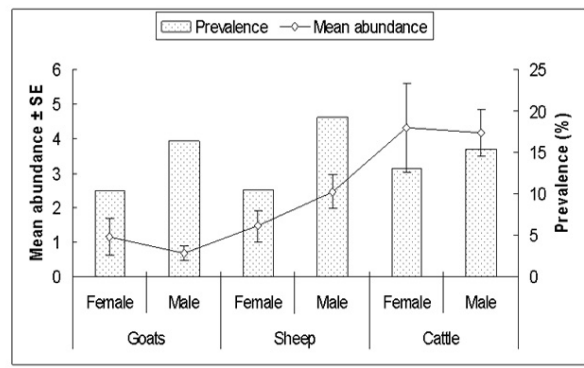

Figure 2. Overall prevalence and mean abundance (± SE) of all helminths combined in different types of livestock per host sex.
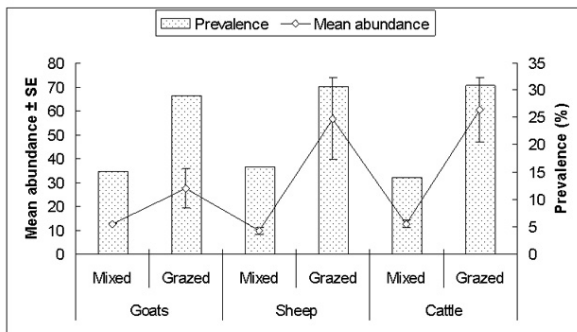

Figure 3. Overall prevalence and mean abundance (± SE) of all helminths combined in different types of livestock per type of diet.
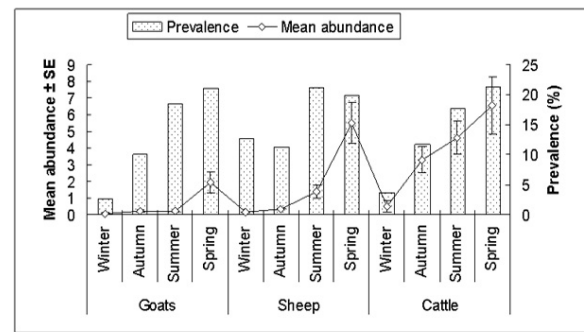

Figure 4. Overall prevalence and mean abundance (± SE) of all helminths combined in different types of livestock during different seasons

There were variations in overall prevalence, mean abundance and mean intensity in livestock animals by host diet. Overall prevalence, mean abundance and mean intensity were higher in grazed animals than that eat mixed food (Fig. 3).

Significant difference were found in overall prevalence, mean abundance and mean intensity in cattle by the diet (χ^2=642.09; *P<0.0001, U*=19.50; *P<0.0001* and *U*=19.50; *P<0.0001* respectively), and sheep (χ^2=1109.28; *P<0.0001, U*=947; *P<0.0001 U*=301; *P=0.008* respectively). In goats, overall prevalence and mean abundance differed significantly (χ^2=973.06; *P<0.0001, U*=170.50; *P<0.0001*) but the mean intensity did not differ significantly.

Data showed significant seasonal pattern in overall prevalence and mean abundance in different studied livestock. Higher overall prevalence recorded during spring in both cattle and goats. However, the higher overall prevalence in sheep recorded during summer (Fig.4). Overall prevalence differed significantly among different seasons in cattle (Fig. 3; χ^2=61.40; *P<0.0001*), in sheep (χ^2=289.01; *P<0.0001*) and in goats (χ^2=96.47; *P<0.0001*). The higher mean abundance recorded in spring in all examined livestock (Fig. 4). There were significant difference in mean abundance among different seasons in both cattle (χ^2=11.47; *P=0.009*) and goats

(χ^2=14.49; *P=0.002*). Significant differences were found in mean intensity among different seasons in goats only (χ^2=8.08; *P<0.04*).

DISCUSSION

Results from this study constitute the first documented information on helminths of veterinary importance in Al-Baha area and are important in the formulation of appropriate control strategies against these parasites in livestock. The present study revealed that helminths community was consisted of nine parasite species, four trematodes (*D. dendriticum*, *F. hepatica*, *F. giagantica* and *P. cervi*), four cestodes (*M. expansa*, *C. bovis*, *C. ovis*, *E. granulosus* (hydatid cysts)) and one nematode (*H. contortus*). These recorded species are in agreement with that reported by Nasher (1990) in Asir province, southwestern Saudi Arabia, except two species; *D. dendriticum* and *F. giagantica*.

The results demonstrated that host age, sex, diet and season played a significant role in determining helminths community species concentration in cattle, sheep and goats. Fuentes et al (2004) showed that the host age seem to play a major role in determining species concentration and helminth diversity, but not in determining the abundance of helminths community of the wood mouse, *Apodemus sylvaticus*.

The present study demonstrated that *E. granulosus* (hydatid cyst) was the most prevalent parasite, followed by *H. contortus* in cattle, sheep and goats. The high prevalence of *E. granulosus* may attributed to the close relation between dog and livestock herds especially in sheep and goats. The close relationship between dog, sheep and man, makes more likely that the life cycle of the parasite can be completed. Its high prevalence is closely connected to the following factors, which are linked to the social and economic conditions of the population: continued widespread use of traditional techniques when raising small ruminants (extensive or semiextensive grazing), illegal slaughtering of the animals, and the presence of high number sheepdogs which gravitate to the sheep raising areas (7). In this study, *H. contortus* has the second rank in overall prevalence in cattle, sheep and goats. Sissay et al (2000) reported that *H. contortus* was the most prevalent parasite in sheep in a semi-arid region of eastern Ethiopia. *H. contortus* showed propensity to undergo arrested development during the dry seasons. Previous studies have shown that between-year transmission of *H. contortus* in Swedish sheep flocks is almost entirely as over-wintered populations within housed animals, and not on pasture (28).

The aggregation index analysis showed that all helminth parasite species recorded in livestock in this study except *M. expansa* were aggregated in their hosts (V/M: I>1). The degree of aggregation of helminths differed according species the host, cattle recorded the highest aggregation index (I) for each helminth parasite species. The present finding may reflect a difference in host size. Cattle have higher host size compared with other examined hosts. Larger hosts simply provide more space and resources, thus supporting larger parasite populations.

The data demonstrated that the prevalence and mean abundance affected by many factors: host sex, diet and season. The prevalence of infection was higher in adult livestock animals than young. This age variation can be translated into differential exposure to infection because older livestock may have been exposed to more infective stages. Parasite host itself (regardless of age) might in fact affect parasite development if, for example, a relatively large host provides space, greater energetic resources, or both, for parasite development. Older livestock have accrued multiple infections. This finding contradicts with the finding of Heath and Harris (1991) but Decker *et al* (2001) found no age- or sex related differences in rodents.

In this study male has higher prevalence than female in all examined livestock animals. Barnard *et al* (2002) explained the reduced resistance and thus greater parasite intensities with male bank voles, which had significantly larger adrenal glands, testes and seminal vesicles correlated for their age. Consequently, the sex-related differences in prevalence and mean abundance recorded in this study may be due to the hormonal activity of the host. Domestic ungulate males have been reported to be more susceptible to infections with gastrointestinal tract parasites than females. This has been attributed to male hormones debilitating immune functions, thereby favouring the growth and success of parasites in their gut (1, 11).

The present data showed that grazed livestock animals have higher infection prevalence and mean abundance. Since most of helminths community is transmitted orally by ingesting the infective stage in contaminated food, its high prevalence in grazed animals may be caused by highly contaminated grazing sites, the reason why grazed goats show high infection intensities. Marley et al (2006) showed that the type of diet affect the faecal egg counts of nematode in cattle and sheep.

The present study demonstrated that the prevalence differed significantly by season. The higher prevalence recorded during spring in some parasite species and the other ones in summer whereas the higher mean abundance for all parasite species was recorded in spring. *Haemonchus* species attained peak counts in goats during spring and sheep during summer (20). Sissay *et al* (2007) demonstrated that the high levels of infection occurred during the short and long rain seasons with peaks occurring in May and September of each year in gastrointestinal nematode infections of sheep in a semi-arid region of eastern Ethiopia. McCulloch *et al* (1986) found that differential egg counts of *Haemonchus* worm populations in Angora goats had higher worm populations in wet as opposed to dry conditions. Sharkhuu (2001) recorded the highest EPG of gastrointestinal helminths in March (spring) and the lowest in November (autumn).

The survival of most of nematodes eggs is higher under moist conditions (25, 24). On the other hand, Vidya and Sukumar (2002) attributed the higher parasite loads in the dry season to various reasons, such as transmission, diet, body condition, and uneven sampling across age classes/ sexes. Not all of these factors can explain our results**.** However, depending on differences in parasite prevalence and abundance that found between the age classes and sex. Such patterns suggest that parasitic infections may have been modulated by host-intrinsic factors, e.g., either by the way of innate or adaptive immunity, in addition to extrinsic factors, e.g., season. Infection levels tended to be higher during the spring and summer seasons in Al-Baha area when the conditions of temperature, humidity and rainfall were more favourable for the development of egg and/or larval stages of parasites compared with the extremely cold winter season and dry autumn. The climate in Al-Baha is dry. Average temperatures range between 6 and 29 ^{0}C/year. Rainfall varies between 100 and 581 mm/year. Moisture varies between 52% and 67%. Therefore, the differences in parasite prevalence among seasons were to be expected.

This data should be helpful in the development of appropriate education, control and prevention strategies of heminths of livestock in Al-Baha area.

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